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BIOLOGICAL INTEGRITY OF BIG DRY CREEK AND LITTLE DRY CREEK GARFIELD COUNTY, MONTANA BASED ON THE COMPOSITION AND STRUCTURE OF THE BENTHIC ALGAE COMMUNITY

Prepared for:

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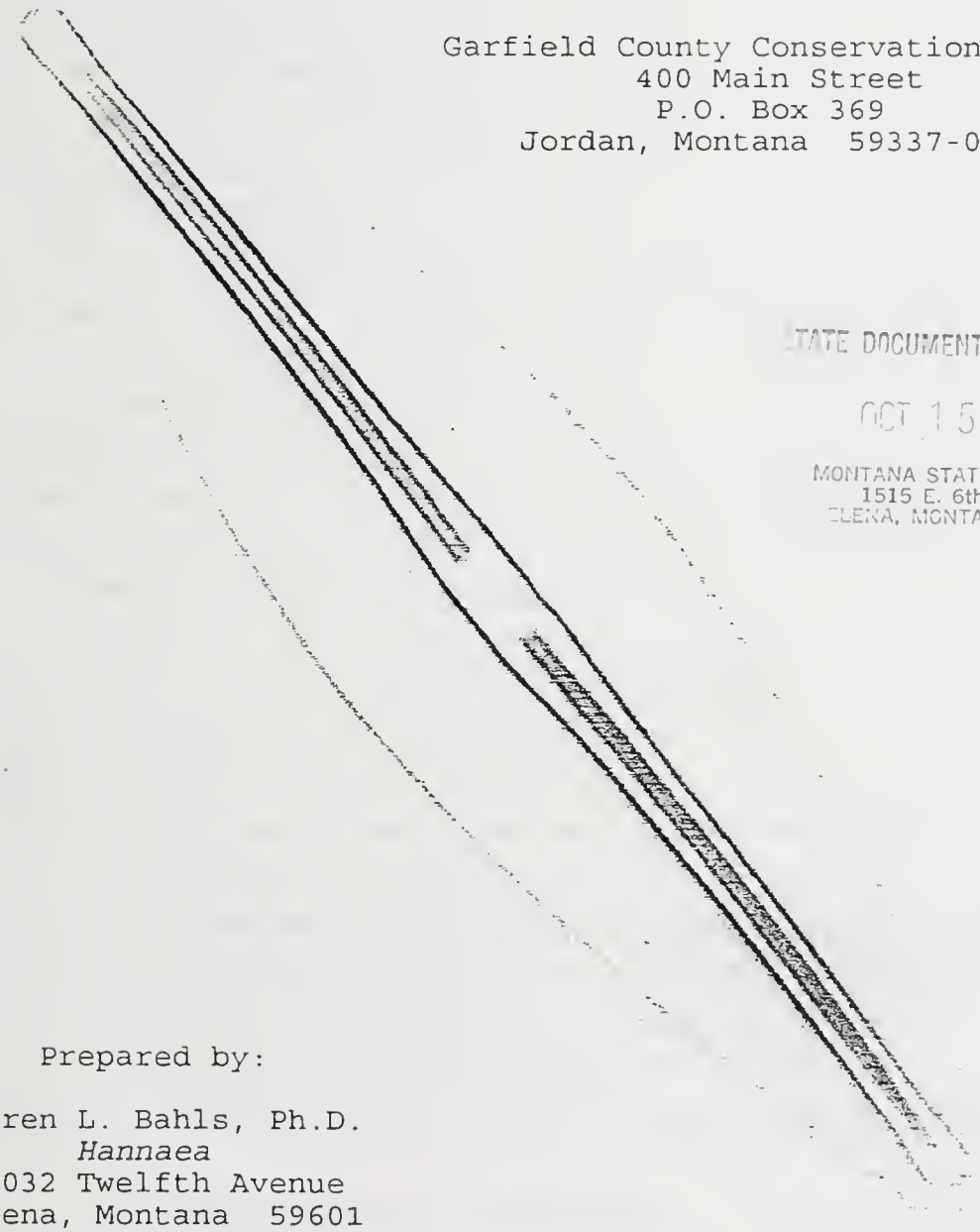

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SUMMARY

Composite periphyton samples were collected from natural substrates in lower Big Dry Creek and lower Little Dry Creek in eastern Garfield County, Montana. Samples were collected following standard operating procedures of the Montana Department of Environmental Quality, processed and analyzed using standard methods for periphyton, and evaluated following modified USEPA rapid bioassessment protocols for wadeable streams.

Most diatom association metrics indicated that **Big Dry Creek** had good to excellent biological integrity when compared to least-impaired reference streams elsewhere in eastern Montana. However, **a very low pollution index resulted in a rating of fair biological integrity, moderate impairment, and only partial support of aquatic life uses.** The low pollution index was the result of excessive organic loading, either from internal sources or from wastewater discharges upstream, or both. The siltation index also indicated problematic conditions in Big Dry Creek.

Potentially toxic blue-green algae were present in Big Dry Creek, but not in sufficient quantities to pose a problem for livestock producers.

All diatom metrics indicated full support of aquatic life uses in Little Dry Creek when compared to other prairie streams. Only a slightly depressed pollution index resulted in a rating of good rather than excellent biological integrity. Little Dry Creek proved to be a suitable local reference stream.

When compared to metric values for Little Dry Creek, the pollution and siltation indexes for **Big Dry Creek** indicated only minor impairment, good biological integrity, and full support of aquatic life uses. The diatom species diversity index was within the range of no impairment and excellent biological integrity.

INTRODUCTION

This report evaluates the biological integrity, support of aquatic life uses, and probable causes of impairment to those uses in Big Dry Creek and Little Dry Creek in Garfield County, Montana. This evaluation is part of an assessment sponsored by the Garfield County Conservation District with assistance from the Natural Resources Conservation Service, U.S.D.A.

The evaluations in this report are based on the structure and species composition of the periphyton or phytobenthos community. The periphyton community is a basic biological component of all aquatic ecosystems. Periphyton accounts for much of the primary production and biological diversity of Montana streams (Bahls et al. 1992).

Periphyton is a diverse assortment of simple photosynthetic organisms called algae, and other microorganisms that live attached to or in close proximity of the stream bottom. Many algae, such as the diatoms, are microscopic. Diatoms are distinguished by having a cell wall composed of opaline glass--hydrated amorphous silica. Diatoms often carpet a stream bottom with a slippery brown film.

Some algae, such as the filamentous greens, are conspicuous and their excessive growth may be aesthetically displeasing. Algae may also deplete dissolved oxygen, interfere with fishing and fish spawning, clog water filters and irrigation intakes, create tastes and odors in drinking water, and generate toxins that may be lethal to livestock and other animals.

Plafkin et al. (1989) and Stevenson and Bahls (1999) list several advantages for using periphyton in biological assessments of streams:

- Algae are universally present in large numbers in all streams and unimpaired periphyton assemblages typically support a large number (>30) of species;

- Algae have rapid reproduction rates and short life cycles, making them useful indicators of short-term impacts;

- As primary producers, algae are most directly affected by physical and chemical factors, such as temperature, nutrients, dissolved salts, and toxins;

- Sampling is quick, easy and inexpensive, and causes minimal damage to resident biota and their habitat;

- Standard methods and criteria exist for evaluating the composition, structure, and biomass of algal associations;

- Identification to species is straightforward for the diatoms, for which there is a large body of taxonomic and ecological literature;

- Excessive algae growth in streams is often correctly perceived as a problem by the public.

- Periphyton and other biological communities reflect the *biological integrity*[1] of waterbodies; restoring and maintaining the biological integrity of waterbodies is a goal of the federal Clean Water Act;

- Periphyton and other biological communities integrate the effects of different stressors and provide a measure of their aggregate impact; and

- Periphyton and other biological communities may be the only practical means of evaluating impacts from non-point sources of pollution where specific ambient criteria do not exist (e.g., impacts that degrade habitat or increase nutrients).

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[1] *Biological integrity* is defined as "the ability of an aquatic ecosystem to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of natural habitats within a region" (Karr and Dudley 1981).

PROJECT AREA AND SAMPLING SITES

The project area is located in Garfield County in east central Montana. Big Dry Creek heads at an elevation of 3,500 feet south of Sand Springs in the southwestern corner of Garfield county. Little Dry Creek heads south of Jordan at about the same elevation. The two streams flow north and east to where they join 26 miles east of Jordan along Montana Highway 200.

The project area is within the Northwestern Great Plains Ecoregion (Woods et al. 1999). The surface geology of the area consists of sandstone and shales of the Hell Creek formation in the headwaters and near the mouth of Big Dry Creek, and rocks of the coal-bearing Fort Union Formation in between (Renfro and Feray 1972). Upland vegetation is predominantly mixed grassland (USDA 1976). The main land use is livestock grazing.

Periphyton samples were collected at one site each on Big Dry Creek and Little Dry Creek (Table 1). The site on Big Dry Creek (#9) is about 2 miles upstream from Fort Peck Reservoir on the Missouri River (Map 1). The site on Little Dry Creek (Map 2) is just above its confluence with Big Dry Creek, which is about 8 miles above Site #9 and 10 miles above Fort Peck Reservoir.

Elevations at the sampling sites are about 2,300 feet for Big Dry Creek and 2,400 feet for Little Dry Creek. Big Dry Creek and Little Dry Creek are classified C-3 in the Montana Surface Water Quality Standards.

METHODS

Periphyton samples were collected following standard operating procedures of the Planning, Prevention, and Assistance Division of the Montana Department of Environmental Quality.

Using appropriate tools, microalgae were scraped, brushed, and/or sucked from natural substrates in proportion to the rank of those substrates at the study site. Macroalgae were picked by hand in proportion to their abundance at the site. All collections of microalgae and macroalgae were pooled into a common container and preserved with Lugol's solution (APHA 1998).

Samples were examined to estimate the relative abundance and rank by biovolume of diatoms and genera of soft (non-diatom) algae according to the method described in Bahls (1993). Soft algae were identified using Dillard (1999), Prescott (1978), Smith (1950), and Whitford and Schumacher (1984). These books also served as references on the ecology of the soft algae, along with Palmer (1977).

After the identification of soft algae, raw periphyton samples were cleaned of organic matter using sulfuric acid, and permanent diatom slides were prepared using Naphrax, a high refractive index mounting medium, following *Standard Methods for the Examination of Water and Wastewater* (APHA 1998). For each slide, between 401 and 412 diatom cells (802 to 824 valves) were counted at random and identified to species. The following were used as the main taxonomic and autecological references for the diatoms: Krammer and Lange-Bertalot 1986, 1988, 1991a, 1991b; Patrick and Reimer 1966, 1975.

Lowe (1974) was also used as an ecological reference for the diatoms. Bahls et al. (1984) provide autecological information on important diatom species that live in the Fort Union Region of Montana, including many of the diatom species found in Big Dry Creek and Little Dry Creek.

The diatom proportional counts were used to generate an array of diatom association metrics (Table 2). A metric is a characteristic of the biota that changes in some predictable way

with increased human influence (Barbour et al. 1999).

Metric values for Big Dry Creek and Little Dry Creek were compared to numeric biocriteria developed for streams in the Great Plains Ecoregions of Montana (Table 3). These criteria are based on metric values measured in least-impaired reference streams (Bahls et al. 1992) and on metric values measured in streams that are known to be impaired by various sources and causes of pollution (Bahls 1993).

The criteria in Table 3 distinguish among four levels of impairment and three levels of aquatic life use support: no impairment or only minor impairment (full support); moderate impairment (partial support); and severe impairment (nonsupport). These impairment levels correspond to excellent, good, fair, and poor *biological integrity*, respectively.

Besides the ecoregional biocriteria listed in Table 3, metrics for Big Dry Creek were also compared to metrics generated from a local, least-impaired reference stream using Protocol II in Bahls (1993). Little Dry Creek was used as the local, least-impaired reference stream.

Protocol II is based on the percentage of change in metric values at the study site(s) from values measured at the local reference stream. Criteria for evaluating biological integrity using Protocol II are given in Table 12 in Bahls (1993).

Protocol II may be used if a tributary stream is available that fully supports its aquatic life uses, that is, if it has a rating of "good" or "excellent" biological integrity using Protocol I. Little Dry Creek exhibited only minor impairment using Protocol I and thereby qualifies as a local reference site.

For Protocol I, only periphyton samples collected in summer (June 21-September 21) can be compared with confidence to reference stream samples because metric values change seasonally and summer is the season in which reference streams and impaired streams were sampled for the purpose of biocriteria development. Protocol II can be used at any time of the year.

QUALTIY ASSURANCE

Several steps were taken to assure that the study results are accurate and reproducible.

Upon receipt of the samples, station and sample information were recorded in a laboratory notebook and samples were assigned a unique number compatible with the Montana Diatom Database, e.g., 1987-01. The first part of this number (1987) designates the sampling site (Big Dry Creek Site #9); the second part of the number (01) designates the number of periphyton samples that have been collected at this site to date for which data have been entered into the Montana Diatom Database.

Sample observations and analyses of soft (non-diatom) algae were recorded in a lab notebook along with station and sample information provided by Warren Kellogg of the NRCS. A portion of the raw sample was used to make duplicate diatom slides.

On completion of the project, station information, sample information, and diatom proportional count data will be entered into the Montana Diatom Database. One set of diatom slides will be deposited in the University of Montana Herbarium in Missoula. The other set of slides will be retained by *Hannaea* in Helena.

RESULTS AND DISCUSSION

Results are presented in Tables 4-6, located near the end of this report following the Literature Cited section. Spreadsheets containing completed diatom proportional counts, with species' pollution tolerance classes and percent abundances, are attached as Appendix A.

FIELD AND SAMPLE NOTES

Big Dry Creek Site #9. The periphyton sample from this site consisted mainly of plant roots. The stream here formed long pools of variable depth. The substrate was a mix of small gravels and silt. Macrophytes were present along the channel edges. Channel alterations and sediment accumulations were minimal. Point bars were active but with little long-term enlargement. The sinuosity was about 2.0-2.5. Banks were stable with good vegetative cover. (Field notes by Warren Kellogg, NRCS, 8/23/00.)

Little Dry Creek above Highway 200. The sample from this site was very silty and was composed primarily of plant roots. About 20% of the diatom cells were empty. Branching was observed in *Rhizoclonium,* but it was rare. Two species of *Oedogonium* were present. The habitat score for this site (115.5) was 68% of the maximum possible (Carol Endicott, MDEQ, personal communication).

NON-DIATOM ALGAE

Big Dry Creek

Big Dry Creek supported a mix of green algae, euglenoid algae (*Euglena*), diatoms, and cyanobacteria (formerly called blue-green algae) (Table 4). Eight genera of non-diatom algae were present, which is less than the average number (13) recorded for reference streams in Great Plains Montana (Bahls 1993).

Diatoms were the most abundant algae, followed by greens, cyanobacteria, and euglenoids. Dominance by diatoms and greens and the occasional cell of *Euglena* indicate moderate nutrient enrichment and organic loading at this site. Nitrogen-fixing cyanobacteria cannot compete successfully with diatoms and greens under such conditions.

Anabaena was one of three nitrogen-fixing cyanobacteria in Big Dry Creek. Under certain conditions, *Anabaena* can produce waterblooms that release neurotoxins into the water. These toxins can be lethal to livestock, pets, and wildlife. However,

Anabaena was not abundant enough in Big Dry Creek to pose a problem for livestock producers.

Little Dry Creek

The sample from Little Dry Creek also contained a mix of green algae, diatoms, euglenoid algae, and cyanobacteria. Only five genera of non-diatom algae were present.

Diatoms dominated the sample from Little Dry Creek, followed by green algae, cyanobacteria, and euglenoids. *Euglena*, a good indicator of organic loading, was rare at this site.

Big Dry Creek and Little Dry Creek had only three genera of non-diatom algae in common: *Oedogonium*, *Euglena*, and *Phormidium*. The absence of *Anabaena* and the abundance of the filamentous green alga *Rhizoclonium* indicates that Little Dry Creek probably had cooler water and more water movement than did Big Dry Creek. It should also be noted that the sample from Little Dry Creek was collected in the Spring, when higher flows and cooler waters are to be expected. The sample from Big Dry Creek was collected in late Summer of a particularly dry year (2000).

DIATOMS

Big Dry Creek

The major diatom species in Big Dry Creek were all somewhat tolerant to very tolerant of nutrient enrichment, organic loading, and elevated dissolved solids (Table 5).

The dominant diatom in Big Dry Creek was *Navicula duerrenbergiana*. This diatom has been reported mainly from brackish seas and coastal waters in Europe and Israel (Krammer

and Lange-Bertalot 1986). In Montana, *Navicula duerrenbergiana* is most common in silty prairie streams, including the lower reaches of the Redwater and Musselshell Rivers (unpublished data). In the Southern Fort Union Coal Region, this taxon has been reported from the lower reaches of Armells, Mizpah, Pumpkin, and Rosebud Creeks, where it prefers warm, brackish waters and tolerates some suspended sediment and turbidity (Bahls et al. 1984).

Next in abundance in Big Dry Creek was *Diploneis puella*. This diatom prefers brackish waters with muddy bottoms. Next in abundance was *Navicula recens*. In Europe, *N. recens* is common in brackish waters and in large rivers, such as the Rhein and the Weser (Krammer and Lange-Bertalot 1986).

Also common in Big Dry Creek, and to a lesser extent in Little Dry Creek, was *Nitzschia palea*. This diatom is very tolerant of organic loading and of low levels of dissolved oxygen. It is a good indicator of nitrogen enrichment.

Little Dry Creek

Diploneis puella--the diatom that prefers brackish waters with muddy bottoms--was also a major diatom species in Little Dry Creek (Table 5). However, also abundant here were *Achnanthes minutissima* and *Cymbella affinis*. Both of these diatoms prefer cool, flowing waters and do not tolerate heavy organic loading or low concentrations of dissolved oxygen. They are sensitive to pollution and are the dominant diatoms in many mountain streams of central and western Montana (unpublished data).

BIOASSESSMENT

PROTOCOL I

Most diatom association metrics for **Big Dry Creek** indicated good to excellent water quality and biological integrity when compared to least-impaired reference streams elsewhere in eastern Montana (Table 5). However, a very low pollution index resulted in a rating of **fair biological integrity, moderate impairment, and only partial support of aquatic life uses.**

The source of the organic loading that resulted in this low pollution index is unknown. It may be natural in origin, that is, internal organic loading resulting from the decay of aquatic plants. Or, it may originate from wastewater discharges upstream in the Jordan area. Or, most likely, it is a combination of these two sources.

A low species diversity index and a large siltation index indicated minor impairment yet good biological integrity and full support of aquatic life uses in **Big Dry Creek**. However, the siltation index was within one percentage point of the threshold for **moderate impairment** for a prairie stream. Such a rating would correspond to fair biological integrity and only **partial support of aquatic life uses.**

All diatom metrics indicated full support of aquatic life uses in **Little Dry Creek** when compared to other prairie streams (Table 5). Only a slightly depressed pollution index resulted in a rating of good rather than excellent biological integrity. Little Dry Creek proved to be a suitable local reference stream for use in Protocol II.

PROTOCOL II

The index of similarity between the two streams was 36.86 (Table 6), indicating that the study stream (Big Dry Creek) shared only about a third of its diatom association with the local reference stream (Little Dry Creek). Normally, such a low similariy index would indicate that some perturbation had caused the the diatom association of Big Dry Creek to be quite different (from that of Little Dry Creek) and that the stream had been moderately impaired. However, the two streams were sampled at different times of the year. Since the abundance of diatom species is highly seasonal, sampling in different seasons may explain much of the floristic difference between the two streams.

When compared to metric values for Little Dry Creek, the pollution and siltation indexes for **Big Dry Creek** indicated only minor impairment, good biological integrity, and full support of aquatic life uses. The diatom species diversity index was within the range of no impairment and excellent biological integrity when compared to Little Dry Creek.

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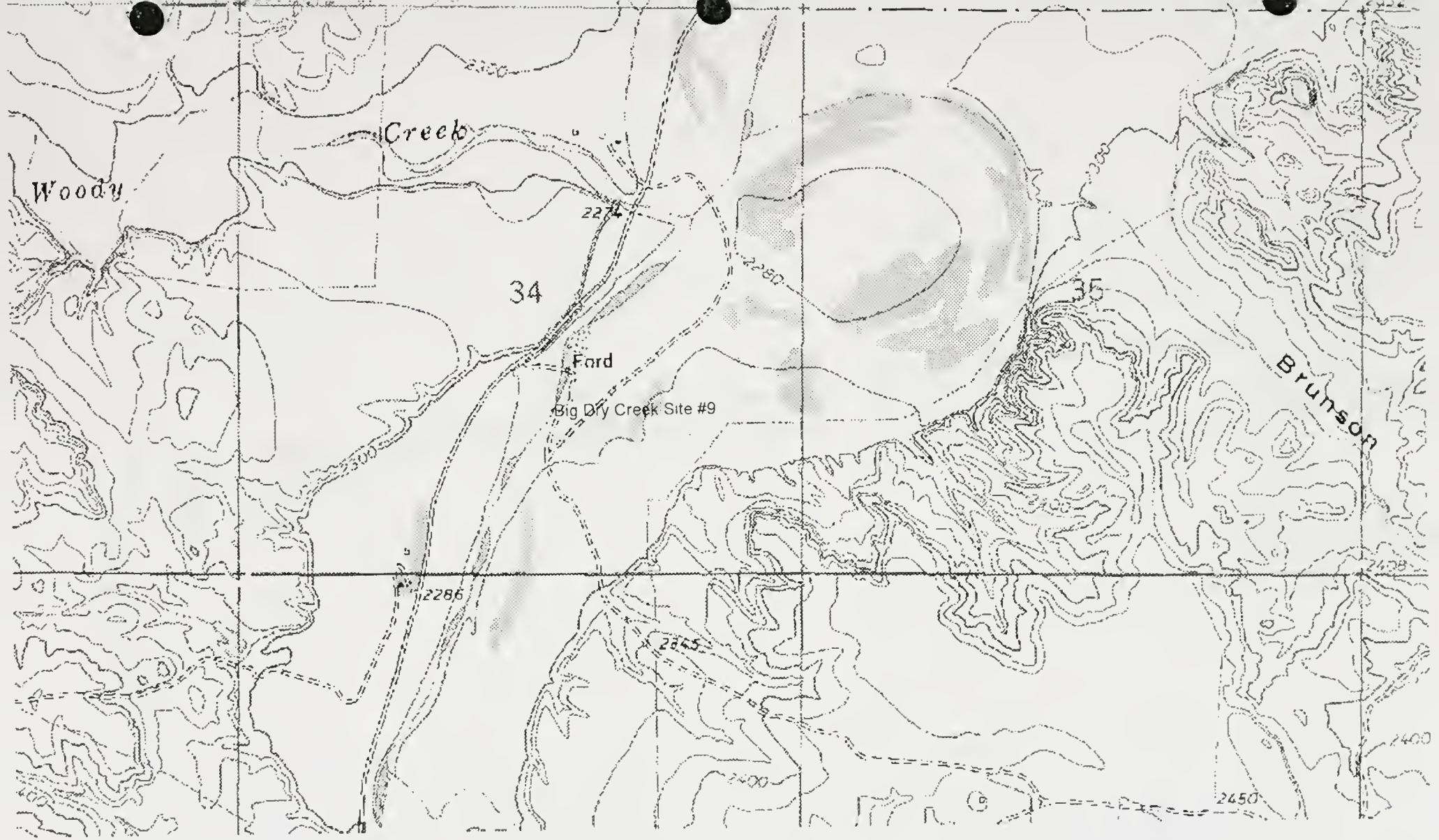
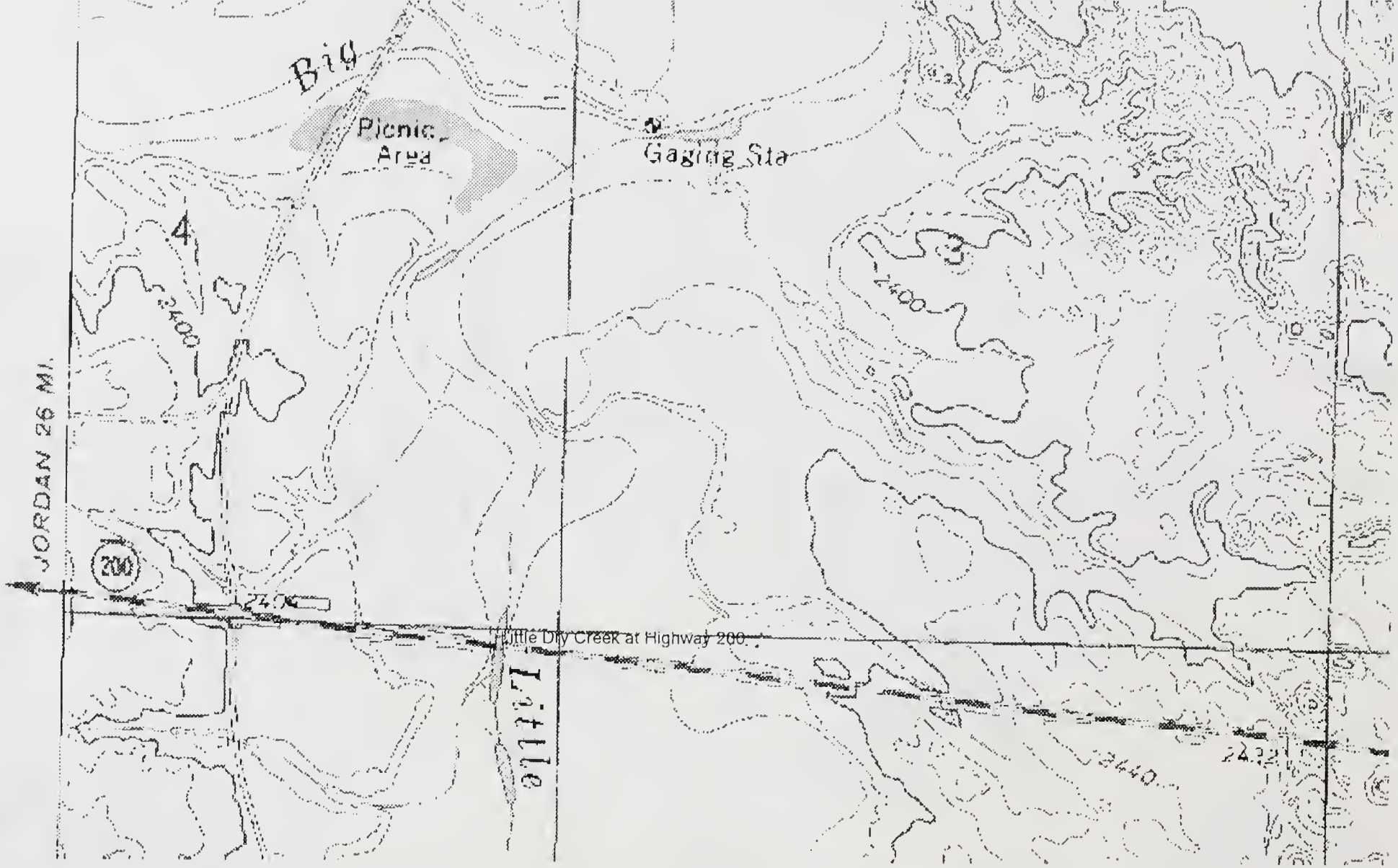


MAP 1

'Frank Coulee, MT'; Scale: 1" = 0.238Mi 383Mt 1,258Ft, 1 Mi = 4.197" , 1 cm = 151Mt



MAP 2

'Coal Creek; MT'; Scale: 1" = 0.179Mi 288Mt 943Ft, 1 Mi = 5.596" , 1 cm = 113Mt

Table 1. Location of periphyton stations on Big Dry Creek and Little Dry Creek near Jordan, Montana: Station codes, sample numbers in the Montana Diatom Database, sample dates, and legal descriptions.

Location	Station Code	Sample Number	Sample Date	Legal Description
Big Dry Creek at Monte Billing Place above ford	Site #9	1987-01	8/23/00	T20NR42E34DB
Little Dry Creek at Highway 200	L. Dry	0745-02	5/27/99	T18NR42E09AA

Table 2. Diatom association metrics used to evaluate biological integrity in Montana streams: reference, range of values in Montana streams, and expected direction of metric response to increasing anthropogenic perturbation or natural stress.

Metric	Reference	Range of Values	Expected Response
Shannon Species Diversity	Bahls 1979	0.00-5.00+	Decrease[1]
Pollution Index[2]	Bahls 1993	1.00-3.00	Decrease
Siltation Index[3]	Bahls 1993	0.00-90.0+	Increase
Disturbance Index[4]	Barbour *et al.* 1999	0.00-100.0	Increase
No. Species Counted	Bahls 1979, 1993	0-100+	Decrease[1]
Percent Dominant Species	Barbour *et al.* 1999	5.0-100.0	Increase
Percent Abnormal Cells	McFarland *et al.* 1997	0.0-20.0+	Increase
Similarity Index	Whittaker 1952	0.0-80.0+	Decrease
Percent Epithemiaceae	Stevenson & Pan 1999	0.0-80.0+	Decrease
Percent Aerophiles	Johansen 1999	0.0-100	Increase

[1] Shannon diversity and species richness may increase somewhat in naturally nutrient-poor mountain streams in response to slight to moderate increases in nutrients or sediment.

[2] Composite numeric expression of the pollution tolerances assigned by Lange-Bertalot (1979) to the common diatom species.

[3] Sum of the percent abundances of all species in the genera *Navicula*, *Nitzschia*, and *Surirella*, plus the species *Cymbella sinuata*.

[4] Percent abundance of *Achnanthes minutissima*.

Table 3. Criteria for rating levels of biological integrity, environmental impairment or natural stress, and aquatic life use support in wadeable **plains** streams of Montana using selected metrics for benthic diatom associations. The lowest rating for any one metric is the overall rating for the study site.

Biological Integrity/ Impairment or Natural Stress/Use Support	Diversity Index (Shannon)	Pollution Index	Siltation Index	Disturbance Index	Number of Species Counted	Percent Dominant Species	Percent Abnormal Cells	Similarity Index[1]
Excellent None/Full Support	>3.99	>2.25	<50.0	<25.0	>39	<25.0	0.0	>59.9
Good/Minor Full Support	3.00-3.99	1.76-2.25	50.0-69.9	25.0-49.9	30-39	25.0 49.9	>0.0-<1.0	40.0-59.9
Fair/Moderate Partial Support	2.00-2.99	1.25-1.75	70.0-89.9	50.0-74.9	20-29	50.0-74.9	1.0-9.9	20.0-39.9
Poor/Severe Nonsupport	<2.00	<1.25	>89.9	>74.9	<20	>74.9	>9.9	<20.0

[1] The Similarity Index or Percent Community Similarity (Whittaker 1952) may be used to compare a study site to an unimpaired upstream control site on the same stream. This metric measures the degree of floristic similarity between diatom associations at the two sites and is the sum of the smaller of the two percent abundance values for each species that is common to both sites. Adjacent riffles on the same stream, without intervening tributaries or environmental perturbations, will generally have at least 60% of their diatom floras in common (Bahls 1993). PCS may also be used to guage the relative amount of impairment or recovery that occurs between adjacent study sites: >59.9% = very similar floras, no change; 40.0-59.9% = somewhat similar floras, minor change; 20.0-39.9% = somewhat dissimilar floras, moderate change; <20.0% = very dissimilar floras, major change.

Table 4. Relative abundance of cells and rank by biovolume of diatoms and genera of non-diatom algae in periphyton samples collected from Big Dry Creek and Little Dry Creek near Jordan, Montana.

Taxa	Relative Abundance and (Rank)	
	Big Dry Creek (8/23/00)	Little Dry Creek (5/27/99)
Chlorophyta (green algae)		
Ankistrodesmus	occasional (8)	
Bulbochaete	occasional (3)	
Cosmarium	occasional (4)	
Oedogonium	common (2)	frequent (3)
Rhizoclonium		abundant (2)
Spirogyra		frequent (4)
Euglenophyta (euglenoid algae)		
Euglena	occasional (9)	rare (6)
Chrysophyta (golden algae)		
Bacillariophyceae	frequent (1)	abundant (1)
Cyanophyta (cyanobacteria)[1]		
Anabaena	occasional (6)	
Calothrix	occasional (7)	
Phormidium	occasional (5)	common (5)

[1] Formerly known as blue-green algae.

Table 5. Percent abundance of major diatom species[1] and values of selected diatom association metrics for periphyton samples collected from Big Dry Creek and Little Dry Creek near Jordan, Montana.

Species/Metric (Pollution Tolerance Class)[3]	Percent Abundance/Metric Values[2]	
	Big Dry Creek (8/23/00)	Little Dry Creek (5/27/99)
Achnanthes minutissima (3)		9.35
Cymbella affinis (3)		7.61
Diploneis puella (2)	16.99	17.71
Entomoneis paludosa (2)	1.33	5.49
Gomphonema parvulum (1)	6.19	0.25
Navicula duerrenbergiana (1)	21.72	0.37
Navicula recens (2)	11.89	
Nitzschia frustulum (2)	5.83	p[4]
Nitzschia palea (1)	9.22	8.48
Cells Counted	412	401
Total Species	48	68
Species Counted	45	66
Species Diversity	3.90	4.82
Percent Dominant Species	21.72	17.71
Disturbance Index	0.00	9.35
Pollution Index	**1.56**	2.01
Siltation Index	69.66	37.14
Percent Abnormal Cells	0.00	0.00
Percent Epithemiaceae	1.09	0.00
Similarity Index	36.86	

[1] A major diatom species is here considered to be one that accounts for 5% or more of the cells in one or more samples of a sample set.

[2] Underlined values indicate good biological integrity, minor impairment, and full support of aquatic life uses; **bold values** indicate fair biological integrity, moderate impairment, and partial support of aquatic life uses; all other values indicate excellent biological integrity, no impairment, and full support of aquatic life uses when compared to diatom criteria for mountain and plains streams in Tables 3 and 4.

[3] 3 = sensitive to pollution; 2 = tolerant of pollution; 1 = most tolerant of pollution.

[4] A "p" indicates that the taxon was recorded as present during a preliminary floristic scan of the diatom slide, but it was not encountered during the diatom proportional count.

Table 6. Metric scores and impairment ratings for Big Dry Creek based on a comparison with Little Dry Creek, following Protocol II and Table 12 in Bahls (1993). Underlined values indicate full support of aquatic life uses, minor impairment, and good biological integrity; **bold values** indicate partial support of aquatic life uses, moderate impairment, and fair biological integrity; all other values indicate full support of aquatic life uses, no impairment, and excellent biological integrity.

Metric	Metric Score (%)
Shannon Diversity Index	80.91
Pollution Index	77.61
Siltation Index	53.32
Similarity Index	**36.86**

APPENDIX A: DIATOM PROPORTIONAL COUNTS

Sample	Genus/Species/Variety	Pollution Tolerance Class	Count	Percent
198701	Amphora veneta	1	0	0.00
198701	Caloneis bacillum	2	1	0.12
198701	Caloneis schumanniana	2	5	0.61
198701	Cyclotella meneghiniana	2	1	0.12
198701	Cymbella pusilla	1	2	0.24
198701	Cymbella silesiaca	2	6	0.73
198701	Diploneis puella	2	140	16.99
198701	Entomoneis alata	2	1	0.12
198701	Entomoneis paludosa	2	11	1.33
198701	Gomphonema gracile	2	2	0.24
198701	Gomphonema parvulum	1	51	6.19
198701	Gyrosigma spencerii	2	0	0.00
198701	Navicula ammophila	2	1	0.12
198701	Navicula capitata	2	0	0.00
198701	Navicula caterva	2	7	0.85
198701	Navicula cincta	1	6	0.73
198701	Navicula cryptotenella	2	2	0.24
198701	Navicula duerrenbergiana	1	179	21.72
198701	Navicula erifuga	2	24	2.91
198701	Navicula omissa	1	4	0.49
198701	Navicula pupula	2	4	0.49
198701	Navicula pygmaea	2	2	0.24
198701	Navicula recens	2	98	11.89
198701	Navicula tenelloides	1	9	1.09
198701	Navicula veneta	1	21	2.55
198701	Neidium ampliatum	3	1	0.12
198701	Nitzschia amphibia	2	8	0.97
198701	Nitzschia archibaldii	2	3	0.36
198701	Nitzschia clausii	2	2	0.24
198701	Nitzschia filiformis	2	17	2.06
198701	Nitzschia frustulum	2	48	5.83
198701	Nitzschia gracilis	2	3	0.36
198701	Nitzschia incognita	2	2	0.24
198701	Nitzschia liebetruthii	2	4	0.49
198701	Nitzschia lorenziana	2	2	0.24
198701	Nitzschia microcephala	1	4	0.49
198701	Nitzschia palea	1	76	9.22
198701	Nitzschia paleacea	2	2	0.24
198701	Nitzschia reversa	2	32	3.88
198701	Nitzschia solita	1	2	0.24
198701	Nitzschia valdestriata	2	6	0.73
198701	Pleurosigma delicatulum	2	6	0.73
198701	Rhopalodia brebissonii	1	4	0.49
198701	Rhopalodia gibba	2	3	0.36
198701	Rhopalodia operculata	1	2	0.24
198701	Surirella brebissonii	2	6	0.73
198701	Synedra acus	2	1	0.12
198701	Synedra delicatissima	2	13	1.58

Sample	Genus/Species/Variety	Pollution Tolerance Class	Count	Percent
074502	Achnanthes minutissima	3	75	9.35
074502	Amphipleura pellucida	2	9	1.12
074502	Amphora dusenii	2	4	0.50
074502	Amphora inariensis	3	2	0.25
074502	Amphora libyca	3	2	0.25
074502	Caloneis bacillum	2	2	0.25
074502	Caloneis schumanniana	2	6	0.75
074502	Cylindrotheca gracilis	2	4	0.50
074502	Cymbella affinis	3	61	7.61
074502	Cymbella cymbiformis	3	10	1.25
074502	Cymbella microcephala	2	27	3.37
074502	Cymbella minuta	2	3	0.37
074502	Cymbella muelleri	2	14	1.75
074502	Cymbella pusilla	1	6	0.75
074502	Cymbella silesiaca	2	1	0.12
074502	Diatoma tenuis	2	15	1.87
074502	Diploneis pseudovalis	2	10	1.25
074502	Diploneis puella	2	142	17.71
074502	Entomoneis alata	2	4	0.50
074502	Entomoneis paludosa	2	44	5.49
074502	Fragilaria vaucheriae	2	36	4.49
074502	Gomphonema parvulum	1	2	0.25
074502	Gyrosigma spencerii	2	2	0.25
074502	Navicula accomoda	1	1	0.12
074502	Navicula capitata	2	4	0.50
074502	Navicula capitatoradiata	2	1	0.12
074502	Navicula caterva	2	10	1.25
074502	Navicula cincta	1	5	0.62
074502	Navicula cincta v. rostrata	1	32	3.99
074502	Navicula circumtexta	1	1	0.12
074502	Navicula cryptocephala	3	2	0.25
074502	Navicula cryptotenella	2	16	2.00
074502	Navicula cuspidata	2	4	0.50
074502	Navicula duerrenbergiana	1	3	0.37
074502	Navicula erifuga	2	13	1.62
074502	Navicula gregaria	2	5	0.62
074502	Navicula minuscula	1	7	0.87
074502	Navicula notha	2	3	0.37
074502	Navicula odiosa	1	2	0.25
074502	Navicula reichardtiana	2	2	0.25
074502	Navicula veneta	1	5	0.62
074502	Navicula viridula v. rostellata	2	3	0.37
074502	Nitzschia amphibia	2	8	1.00
074502	Nitzschia apiculata	2	10	1.25
074502	Nitzschia bergii	1	8	1.00
074502	Nitzschia filiformis	2	7	0.87
074502	Nitzschia frustulum	2	0	0.00

Sample	Genus/Species/Variety	Pollution Tolerance Class	Count	Percent
074502	Nitzschia frustulum v. subsalina	2	5	0.62
074502	Nitzschia gracilis	2	4	0.50
074502	Nitzschia levidensis	2	4	0.50
074502	Nitzschia microcephala	1	6	0.75
074502	Nitzschia palea	1	68	8.48
074502	Nitzschia paleacea	2	21	2.62
074502	Nitzschia perminuta	3	2	0.25
074502	Nitzschia perspicua	1	5	0.62
074502	Nitzschia recta	3	3	0.37
074502	Nitzschia reversa	2	4	0.50
074502	Nitzschia sigma	2	2	0.25
074502	Nitzschia solita	1	0	0.00
074502	Nitzschia valdestriata	2	6	0.75
074502	Pinnularia microstauron	2	4	0.50
074502	Rhoicosphenia curvata	3	4	0.50
074502	Simonsenia delognei	2	4	0.50
074502	Stauroneis tackei	2	2	0.25
074502	Stephanodiscus hantzschii	2	6	0.75
074502	Surirella brebissonii	2	16	2.00
074502	Synedra delicatissima v. angustiss	2	1	0.12
074502	Synedra fasciculata	2	2	0.25